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Technical Sessions Summary

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COMMUNICATION • TRAINING • TECHNOLOGY SUPPORT •

Technical Support Project

U.S. EPA TECHNICAL SUPPORT PROJECT CO-CHAIRS

Engineering Forum:
Chet Janowski, Region 1 • Camille Hueni, Region 6 • Neil Thompson, Region 10

Ground Water Forum:
Kathy Davies, Region 3 • Vince Malott, Region 6

Federal Facilities Forum:
Steve Hirsh, Region 3 • Craig Thomas, Region 5 • Chris Villarreal, Region 6

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TUESDAY FIELD TRIPS

The Engineering Geology of the Big Dig Project

The Engineering Forum attended an all-day guided field trip of the Big Dig Project in downtown Boston. The field trip emphasized the environmental aspects of constructing a tunnel for Boston's Central Artery.

Arsenic in Ground Water, Fort Devens, Massachusetts

The Ground Water Forum attended a half-day field trip consisting of presentations and field stops in Devens, Massachusetts. Ft. Devens is a former Army base 35 miles west of Boston. The base closed under the Base Realignment and Closure Act in 1996 following close to 80 years of operation.

The field trip started with presentations by Professor Rudi Hon (Boston College) and ? that provided an overview of the issue of elevated arsenic in New England ground water. Elevated levels of arsenic have been found in New England ground-water public supply wells from Maine to Massachusetts. The source of this arsenic is not certain, but may be related to regional bedrock geology or land use, such as landfills, tanneries, and the application of arsenical pesticides to crops. Arsenic is mobilized under conditions of pH greater than 7 or dissolved oxygen less than 1 mg/L. Arsenic in private wells has been linked to increased cancer mortalities.

A study performed by the Massachusetts Department of Environmental Protection (MADEP) tried to find a correlation between the application of lead arsenate to orchards, which occurred from the early 1900s to the 1940s, to arsenic in groundwater. The number of orchards per town was found to correlate somewhat to the distribution of arsenic. Most of the MADEP soil samples were shown to have concentrations of arsenic well above the Massachusetts background concentration of 17 mg/kg. MADEP's analysis of lead in the samples showed concentrations to decrease with depth, indicating a better correlation with atmospheric deposition. Although the lead and arsenate components of the pesticide may have taken different transport routes, the difference in distribution patterns of arsenic and lead in the soil suggest elevated concentrations are not solely due to pesticide application.

Analysis of rock fragments in soil cores show that sulfides have replaced chlorides in minerals. The sulfide minerals may be the primary arsenic-bearing phase in the subsurface. X-ray analysis of the a bedrock core taken near the top of bedrock in Devens shows that arsenic, cobalt, and sulfide dominate, with some iron present. The stoichiometry is consistent with the mineral cobaltite.

FIELD STOP 1: Grove Pond Well Field and Treatment Plant

Rick Lindy (Town of Ayer Water Department) explained that the citizens of Ayer were very concerned about reopening the old water supply wells after they had been closed due to high iron and manganese concentrations. The town reopened the two existing wells and is installing a third well to keep up with demand. A treatment plant built to remove the excess iron and manganese had the added benefit of lowering the arsenic levels to non-detect. The system has been very effective at treating the 40-60 ppb of arsenic in the raw water.

Forest Lyford (USGS) noted that the well field area receives 45-50 inches of rainfall per year, with 20-22 inches lost to evapotranspiration. One quarter of the water used in Massachusetts comes from ground water—mainly from gravelly glacial deposits. The valley-fill ground-water systems are being used to capacity, so crystalline bedrock sources are being explored. These bedrock sources typically yield 5-10 gpm, but fractured bedrock sources can yield more. There is a strong connection between ground water and surface water in the area. Pumping of bedrock wells commonly draws water from nearby surface waters or a surficial aquifer.

Janet Stone (USGS) explained that the local surficial geology is a result of the last retreating glacier, which left stratified deposits and meltwater deposits. As the glacier retreated to the north, meltwater deltas formed with the finest sediments deposited furthest from the glacial margin. The morphological sequences in the Nashua River Valley are about 1-2 miles apart.

David McTique and Carol Stein (Gannett-Fleming) summarized the affect of the well field on the adjacent pond. The investigation of the ground-water/surface water interactions was driven by community concerns regarding the arsenic-contaminated bottom sediments of the pond. Although the pond water itself is clean, it is possible that pond water drawn down through the sediments during pumping of the water supply wells would become contaminated with arsenic.

Since the well field was closed in 1985, it was assumed that ground water and surface water conditions had reached a non-stressed state. When the well field pumps were turned on again, monitoring showed that arsenic concentrations actually decreased with time and water from the pond was not being captured. No arsenic was detected in the monitoring wells flanking the production wells and screened at the same intervals.

To determine whether ground water was being drawn from below the level of the production wells, a monitoring well was installed into bedrock, which is about 110 feet bgs. During installation, redox was continually monitored with depth. Ground water was also sampled as the well was drilled. Arsenic concentrations were found to increase with depth until a depth of 43 feet; arsenic was not detected in subsequent deeper ground-water samples. The observed arsenic levels corresponded with the iron levels in the ground water. Based on the sampling results, it was determined that the production wells are screened at the redox zone. The increase of chloride concentrations while pumping indicated that the production wells are drawing water from the opposite side of the pond.

The tannery responsible for the elevated As concentrations in the pond sediments agreed to clean them up, but the contamination is not known to be impacting ecological resources.

FIELD STOP 2: Shepley’s Hill Landfill

Dave Margolis (USACE) and Stan Reed (Harding Lawson Associates) provided an overview of the contribution of the Shepley’s Hill Landfill to elevated concentrations of As in ground water. The army operated the municipal solid waste landfill from 1917 to 1992. Prior to 1917, the landfill was operated by the town. The landfill was filled along the north-south trending valley between Shepley’s Hill and a kame terrace. There has been no record or discovery of hazardous waste buried at the landfill.

The landfill was closed with the installation of an 84-acre cap consisting of a geomembrane layer, sand, and topsoil. The remedy selection process indicated that the cap with ground-water monitoring was adequate. The remedy also calls for the pumping and treating of ground water if arsenic levels do not decrease.

The overburden in the area of the landfill generally consists of fine sand with some sand and gravelly sand lenses. The underlying bedrock is composed of quartz-feldspar gneiss, quartz-feldspar granulite, and phyllite. The area coincides with mapped regions of bedrock contributing to elevated arsenic levels in ground water. Measured concentrations of arsenic in ground water beneath the landfill are as high as

6,000 g/L in the northwest quadrant, and concentrations along the eastern edge of the landfill range from 400-500 g/L. The elevated arsenic levels coincide with high iron and manganese concentrations and a low oxygen-reducing potential (ORP). Essentially all of the arsenic in ground water exists in the dissolved state.

Analysis of rock chip samples in the northwest quadrant of the landfill, where the highest arsenic concentrations in ground water were measured, were 43 and 81 mg/kg. The site conceptual model for the solubilization of this arsenic is as follows: Aerobic weathering of the parent material dissolves arsenic, iron, and manganese. Under aerobic conditions within the aquifer, the iron and manganese precipitate as oxides and hydroxides, and the arsenic sorbs to the precipitates. The landfill creates reducing conditions, however, that dissolve the oxides and hydroxides, releasing the arsenic.

PRESENTATIONS, PANEL DISCUSSION/WRAP UP

The field visits and discussions were followed by additional presentations and a panel discussion of issues regarding arsenic in ground water. The following presentations were made:

Sources and Geochemical Associations of Arsenic in Leachate Plumes from a Landfill in Saco, ME
John Colman, U.S. Geological Survey

Arsenic Sources, Geochemical Associations, and Simulated Transport in Ground-Water Leachate Plumes from Saco Municipal Landfill, Saco Maine
John Colman, U.S. Geological Survey

Borehole Geophysical and Sampling Techniques
Peter Thompson, Harding-ESE
To view Mr. Thompson’s presentation materials for details, click here.

Overview of Site Characterization for Arsenic Contaminated Ground Water
Robert Ford, U.S. EPA/ORD/NRMRL/Subsurface Protection Research Division-Ada

The panel took questions from the audience.

WEDNESDAY JOINT SESSIONS

Introductory Remarks

Larry Brill, U.S. EPA/Region 1 Chief, Superfund Cleanup Branch

Larry Brill, Region 1 Chief, Superfund Cleanup Branch, welcomed the Technical Support Project (TSP) participants to Cambridge. Mr. Brill indicated that Region 1 is a strong supporter of the TSP. He expressed appreciation for the participation of Bill Brandon, Meghan Cassidy, Ray Cody, Sharon Hayes, Chet Janowski, Steve Mangion, Ernie Waterman, and Dick Willey in the Forums, indicating that he greatly values their dissemination of technical information on innovative technologies.

In Region 1, peer review groups evaluate cleanup alternatives for each site. EPA is slowly moving away from advocating the use of traditional cleanup methods, like capping and pump and treat, in favor of more innovative alternatives. The Superfund Division strives to maximize treatment effectiveness while minimizing cost. TSP facilitates the transfer of information on innovative and cost-effective treatments to RPMs in the Regions, allowing them to learn from other RPMs' experiences without assuming the risks associated with using new technologies. This discussion is timely considering that the Agency recently adopted a new standard for arsenic. EPA, with the TSP's help, will need to investigate and test new technologies that will enable the Agency to meet the new standards within current budget limitations.

ORD Hazardous Substances Technical Liaison Program

Michael Gill, U.S. EPA/Region 9 HSTL

Mike Gill, Region 9's Hazardous Substances Technical Liaison (HSTL), indicated that ORD's Superfund Technical Liaison (STL) Program has recently been renamed the HSTL Program to reflect the program's support to both the Superfund and RCRA Programs. HSTLs serve as links to the ORD laboratories for technical support and research. They facilitate the incorporation of sound science and technology into Regional decisions. HSTLs also assist in ORD's research planning, provide feedback to ORD on how to improve Regional products and services, build ORD-supported technical capacity in the Regions, and interact with other organizations involved in environmental research.

Eight of the ten EPA Regions have HSTLs available to assist RPMs and OSCs by disseminating information and putting them in contact with experts in the ORD laboratories. HSTLs do not actually conduct research themselves. RPMs can get technical support from a number of sources, including Regional technical support teams, the TSP forums (Engineering, Ground Water, and Federal Facilities), contractors, or ORD's HSTLs, technical support centers, or research division.

To accomplish their objectives, HSTLs coordinate Regional technical support requests with the Technical Support Centers. In addition, they arrange and attend meetings, workshops, seminars, and conferences on topics of interest to Regional RPMs and OSCs. HSTLs participate in research planning with Regional Science Councils and Research Coordination Teams. HSTLs are sometimes asked to perform tasks, such as grant proposal relevancy reviews, for the NIEHS Superfund Basic Research Program and HSRCs. Finally, they act as liaisons between EPA and other state, federal, or international agencies.

The HSTLs publish a newsletter (available through EPA's Intranet) that keeps ORD and the Regions informed about each other's activities and research agendas.

Questions and Answers:

Question: Do the HSTLs and ORD laboratories hold regularly scheduled meetings?
Answer: No. The majority of our daily dialogue with the ORD laboratories involves specific technical support requests from the Regions. A regularly scheduled conference call would be a good idea, however. The HSTLs have regularly scheduled conference calls among themselves every two weeks and also participate in TSP teleconferences every month.

Comment: Jon Josephs (Region 2 HSTL) added that, in addition to attending meetings and workshops, HSTLs plan them as well. Upcoming HSTL-organized workshops include a sediments workshop in Las Vegas in February and a workshop on ground-water contamination from agricultural pesticides.

Question: How is your RCRA support funded?
Answer: Through Headquarters.

To view Mr. Gill's presentation materials for more details, click here:

ORD Update

Randy Wentsel, U.S. EPA/ORD–Headquarters

Randy Wentsel explained that ORD's mission is to provide a scientific foundation to support EPA's mission to protect human health and the environment. Sound science requires relevant, high quality, cutting edge research in human health, ecology, pollution control and prevention, and socio-economics. HSTLs help ORD carry out their mission by acting as liaisons between ORD and the Regions. ORD Headquarters and the HSTLs have semimonthly teleconferences, and anyone is welcome to join the call to present issues or simply listen in.

Mr. Wentsel noted that the TSP is an excellent group to work with because it initiates discussion on a broad range of issues from every Region. OSP funds numerous workshops every year, and these meetings are often planned or led by HSTLs.

ORD's National Health and Environmental Effects Research Laboratory (NHEERL) is the Agency's focal point for scientific research on the effects of contaminants and environmental stressors on human health and ecosystem integrity. NHEERL has four ecological effects divisions that are located bio-geographically.

The Mid-Continent Ecology Division (MED) in Duluth, MN, with its field location in Grosse Ile, MI, is responsible for providing the scientific information on ecotoxicological and freshwater ecological effects necessary to reduce the uncertainty in risk assessments and support risk management option selections. The MED accomplishes this mission by conducting research to increase understanding and predictive capability for mechanisms of toxicity to aquatic life and wildlife; toxicokinetics and delivered dose of chemicals; dose-response relationships for stressors on aquatic and wildlife populations, communities and ecosystems; and effects of watershed structure and function on aquatic resources. The MED supports EPA's community-based approach to ecosystem protection by coordinating ORD's ecological effects research to address critical scientific issues facing the Great Lakes and the Great Plains regions.

The Atlantic Ecology Division (AED) in Narragansett, RI, is responsible for marine, coastal, and estuarine water quality research. The mission of the AED is to develop and evaluate theory, methods and data to better understand and quantify the environmental effects of anthropogenic stressors on the coastal waters and watershed of the Atlantic seaboard. AED provides research support to EPA program offices and Regions on issues related to the protection of coastal marine ecosystems. Areas of research specialization at the AED include understanding, quantifying, and modeling the cumulative effects of multiple anthropogenic stressors on coastal ecosystems; development of methods for assessing the ecological effects of contaminated marine sediments; development of species, population, and community-level indicators of ecological impacts resulting from anthropogenic activities; place-based integrated ecological assessments for the Atlantic Coast; and information management of regional-scale environmental monitoring data.

The Gulf Ecology Division (GED) of NHEERL is located in Gulf Breeze, FL, and is responsible for study of the physical, chemical, and biological dynamics of coastal wetlands, estuaries, and near-shore marine environments. GED's goal is to protect and preserve the living resources of the Gulf of Mexico and similar environments by providing descriptive data and developing diagnostic procedures to characterize the ecological condition of near-coastal areas and corresponding watersheds, describing sources and causes, and evaluating rates of environmental decline.

The Western Ecology Division (WED), which is located in Corvallis, OR, addresses scientific issues of major importance in formulating public policies, programs, and regulations to protect and manage ecological resources. WED scientists conduct research in a range of scientific disciplines, usually working in multi-disciplinary teams. In addition to their work at the Division's facilities and field sites, they collaborate with leading scientists at research institutions throughout the world. The research addresses the ecological processes that determine the response of biological resources to environmental change and to land and resource use. Priority is given to those ecological systems at greatest risk, with emphasis on the scientific uncertainties that most seriously impede ecological risk assessment.

To view Mr. Wentsel's presentation materials for more details, click here:

Questions and Answers:

Question: Can EPA employees access the NHEERL laboratories the same way they access the other ORD laboratories?
Answer: Yes. If you have an issue or question, you may contact experts at these laboratories directly or through the HSTLs.

Question: Do the NHEERL laboratories have a website?
Answer: The websites for the laboratories are as follows: MED: www.epa.gov/med/; AED: www.epa.gov/aed/; GED: www.epa.gov/ged/; and www.epa.gov/wed/.

Update from the Office of Research and Development/National Risk Management Research Laboratory-Cincinnati

Dave Reisman, U.S. EPA/ORD/NRMRL–Cincinnati

Dave Reisman, Director of ORD's Engineering Technical Support Center (TSC), provided an update on research activities within NRMRL with a focus on ongoing work in Cincinnati. The Engineering TSC has provided approximately 1,000 site assistance actions in the past three years and support for over 250 different sites including CERCLA, RCRA, BRAC, federal, and brownfields facilities. In addition to the Engineering TSC, the NRMRL provides technical assistance through the Ground Water TSC (Ada, OK), the Center for Subsurface Modeling Support (Ada, OK), and the Center for Technology Transfer (Cincinnati, OH). The Directors of these centers are Dave Burden, Dave Jewett , and Joan Colson, respectively. ORD programs associated with the TSCs include the Superfund Innovative Technology Evaluation (SITE) and Environmental Technology Verification demonstration programs, the Mine Waste Technology Program, and the EPA and ORD sediments programs.

Dr. Reisman noted that key ORD remediation issues include contaminated sediments, mining activities, brownfields redevelopment, complex hydrogeologic sites, DNAPL source areas, and landfills. Key research activities include human health and ecological risk assessment, site characterization, remedial technology, fate and transport of contaminants, waste management technology, and prevention. Dr. Reisman summarized some of the sites and activities associated with each remediation issue—particularly the work with contaminated sediments, capping, and natural recovery. He also addressed the work with bioreactors, which are controlled landfills designed and operated to actively degrade waste.

Dr. Reisman concluded his presentation by acknowledging that a number of significant technical issues remain within ORD research areas. The trend in research is toward faster, cheaper, and more effective techniques, ecological impacts, brownfields, watersheds, treatment trains, near-term to long-term remediation action performance, and risks. Dave credited many members of the staff at NRMRL for their role in technical support. He noted the increasing recognition of the role of technical support. The publishing of peer review journal articles is now equivalent to technical support publications.

Questions and Answers

Question: Should technical support requests be submitted to the HSTLs or directly to researchers?
Answer: The requests should be submitted through the liaisons, but copy me on the request.

Question: Is there a list of technical experts, by discipline, for all of the ORD laboratories?
Answer: No, but the Center Directors can be contacted to identify the appropriate experts for a project.

Question: Who decides which expert and laboratory will be assigned to a project, particularly if several laboratories share a specific expertise?
Answer: The Center Directors decide who to assign to a project. They will also transfer a request to the appropriate laboratory if their own laboratory does not possess the relevant expertise. HSTLs can help direct a request to the appropriate laboratory as well.

To view Dr. Reisman's presentation materials for more details, click here:

Update from the Office of Research and Development/National Environmental Risk Laboratory

Ken Brown, U.S. EPA/ORD/NERL/Environmental Sciences Division

Ken Brown provided an overview of the research at the National Environmental Risk Laboratory (NERL), which provides scientific tools to reduce and quantify the uncertainty involved in the Agency's exposure and risk assessments of environmental stressors. The NERL conducts multi-media research on stressor sources, pollutant transport, and transformations/exposures, and develops source-to-receptor predictive exposure models. NERL also provides risk managers with site-specific receptor/stressor analyses and evaluations of alternative migration, management, or restoration strategies from an exposure perspective. As part of this mission, NERL demonstrates, field tests, and evaluates innovative technologies for exposure assessment.

As one of NERL's seven divisions and operation offices, the Environmental Sciences Division (ESD) in Las Vegas conducts research, development, and technology transfer programs on environmental exposures to ecological and human receptors. The ESD is responsible for developing methods for characterizing chemical and physical stressors, with special emphasis on ecological exposure. The Division also conducts analytical chemistry research and applies advanced monitoring technology to issues involving surface and subsurface contamination. In addition to conducting extensive research on landscape ecology, the ESD works to advance scientific understanding in NERL's "waste thrust areas" of Superfund, RCRA, and oil spill issues.

Within these waste thrust areas, NERL's mission focuses on research regarding:

Surface/subsurface characterization and sampling
Site characterization and measurement
Field and laboratory analytical methods
Technical support for site characterization
Multipath exposure modeling and fate processes
Oil spill/dispersant model development.

Update from the Office of Research and Development/National Risk Management Laboratory-Ada
Cynthia Paul, U.S. EPA/ORD/NRMRL–Ada

Cynthia Paul provided an overview of the research being conducted at the NRMRL's Subsurface Protection and Remediation Division (SPRD) in Ada, OK, and a summary of her own research into the in situ reduction of hexavalent chromium (Cr^{6+}).

SPRD has four branches: 1) Technical and Administrative Support Staff, which provides and maintains the infrastructure necessary for carrying out the mission of the SPRD; 2) Technical Assistance and Technical Transfer Branch, which is responsible for communicating and applying SPRD's technical expertise to Agency problems in all areas of environmental science; 3) Ecosystem and Subsurface Protection Branch, which focuses on ecosystems restoration; and 4) Subsurface Protection Branch, which conducts research into defining the chemical, physical, and biological processes that affect the fate, transport, and remediation of contaminants in the subsurface.

Ms. Paul summarized the research specialties of various scientists at SPRD. In addition, ManTech and Dynamac provide contractor support to the research efforts.

The first permeable reactive barrier (PRB) for a mixed contaminant plume was installed at the U.S. Coast Guard Support Center site near Elizabeth City, NC, to treat ground water contaminated with trichloroethene (TCE) and Cr^{6+}. The PRB contains zero-valent iron and was installed to intercept the plume before it discharges to the Pasquotank River. In 1994-1995, an increase in Cr^{6+} was observed in ground water at the site. The explanation for the increase was determined to be a broken water main beneath an electroplating shop. The water increased the mobility of spilled chromate.

To address the source of Cr^{6+}, the site was extensively characterized by collecting soil cores and conducting preliminary screening with x-ray fluorescence (XRF). Total chromium was measured using inductively coupled plasma (ICP), with selective extractions for Cr^{6+}. Geoprobe rigs were used to collect soil samples inside the shop. The results showed the highest total chromium concentrations at depths of 2 feet and 6 feet bgs.

Ms. Paul selected an in situ redox manipulation technology for reducing Cr^{6+} to trivalent chromium (Cr^{3+}). This technology involves the injection of a chemical—in this case sodium dithionite—into the affected areas. The sodium dithionite reduces naturally occurring iron to ferrous iron, which in turn reacts with Cr^{6+} to reduce it to Cr^{3+} ($HCrO^{4-} + 3Fe^{2+} + 7H^{+} \quad Cr^{3+} + 3Fe^{3+} + 4H_2O$). Field-scale testing was conducted by injecting a solution of distilled and deionized water with sodium dithionite, potassium bicarbonate, and bromide tracer. Based on the results of the field-scale testing and laboratory tests, the process has proven to be effective with no adverse side effects. The tests also showed potential for long-term reduction of Cr^{6+}. Full-scale implementation of the sodium dithionite injections began at the Support Center in May 2001 and has been effective to date.

Questions and Answers

Question: How much does a full-scale implementation cost?
Answer: Approximately $500K, but the cost does not include laboratory analytics.

Question: Have you encountered any regulatory hurdles?
Answer: Yes. It took a long time to obtain a permit from the state to perform the sodium dithionite injections.

Question: What changes in water chemistry did you observe?
Answer: The pH increased dramatically, but tailed off. Iron concentrations also increased. The sodium dithionite is malodorous until it breaks down.

Question: Have you assessed the long-term performance of the technology?
Answer: A high manganese oxide concentration is needed to re-oxidize the Cr^{3+}, and there is very little manganese at the site. Therefore, it would be difficult to accomplish.

Question: What level of naturally occurring iron is required?
Answer: Iron levels must be fairly high. The Elizabeth City site has 8-10% iron. (EDX and SEM were used to analyze the silicate minerals in the soil for iron.)

Question: Must the sodium dithionite be pumped back out?
Answer: No. It degrades.

Question: Does the process have any effect on the TCE plume?
Answer: There is a small reduction in TCE concentration in the plume as a result.

To view Ms. Paul's presentation materials for more details, click here:

Hydrogeologic Setting and Ground-water Use in the MMR Regional Area

Denis LeBlanc, U.S. Geological Survey

The Massachusetts Military Reservation (MMR) is located on the western portion of Cape Cod, approximately 65 miles southeast of Boston. Both Otis Air Force Base and Camp Edwards occupy the site. The southern portion of the MMR is highly developed and contains numerous base-related facilities, while the northern portion is relatively undeveloped and includes several firing ranges and impact zones.

The MMR sits atop the Sagamore Aquifer, a sole source aquifer that contains the largest fresh water lens on Cape Cod. The Buzzards Bay Moraine and the Sandwich Moraine lie to the east and west, respectively. The Sagamore Aquifer has a high ground-water infiltration rate (approximately 25-30 in/year). The recharge rate for the aquifer is between 1.5 and 2 million gallons per day. The peak of the ground-water lens is 70 feet above sea level and is located near the impact zone in the northern portion of the MMR. Ground water flows radially outward from the top of the freshwater mound toward the coast. Because the Sagamore Aquifer is a thin hydrologic system, most groundwater flow is horizontal. Several hydrologic features, including glacial kettle lakes, freshwater ponds, and streams, interfere with the normal flow of water toward the coast. The kettle lakes and ponds capture ground-water discharge, hold the water for a short period, and reintroduce it to the aquifer.

Several contaminant plumes originating on the grounds of the MMR have infiltrated the Sagamore Aquifer. These plumes migrate in the direction of ground-water flow radially away from the MMR and toward the coast. A number of plumes have contaminated lakes and streams south of the MMR. The contaminant plume from the Ashumet Valley Sewage Disposal Area is 15 miles long.

To view Mr. LeBlanc's presentation materials for more details, click here:

Perspectives on Superfund Remediation Activities at MMR

Robert Gill, Air Force Center for Environmental Excellence; Leonard Pinaud, Massachusetts Department of Environmental Protection; and Paul Marchessault, U.S. EPA/Region 1

The MMR has three main areas: an industrial complex situated in the southern portion of MMR; a 14,700-acre impact area in the northern portion; and an 840-acre Veterans Administration cemetery. The designated Superfund site is mainly located within the southern portion of the MMR. In November 1989, U.S. EPA placed MMR on the National Priorities List (NPL). A Federal Facility Agreement (FFA) between the Department of Defense, Nation Guard Bureau (NGB), U.S. Coast Guard, and EPA was signed in 1991 and updated in 1997. The FFA established a procedural framework for ensuring that appropriate response actions are implemented and required the Air National Guard to take the lead in the cleanup activities at MMR. There are currently 77 sites being investigated for contamination at the MMR.

Paul Marchessault provided a brief overview of the site history. A chemical spill occurred on the site in 1993. In 1995, the landfill was capped. In 1996, a technical review and evaluation team (TRET) was formed. In 1996, the Air Force Center for Environmental Excellence (AFCEE) assumed responsibility for the Installation Restoration Program. Between 1997 and 2001, numerous treatment systems have become operational at the different operable units. By 2004, all the remedial systems should be installed, and the site will enter the operation and maintenance/monitoring phase.

Robert Gill discussed community involvement activities at the MMR. Over $500 million has been spent on cleaning up the site in the past few years. Most of that money has gone into site assessments and the construction and operation of treatment systems. Between 1982 and 1990, there were minimal community involvement activities at the MMR. This led to mistrust and finger pointing. Between 1990 and 1993, the site managers began an effort to inform the public of site activities and findings. By 1995, a Plume Response Plan was issued by a Citizen's Advisory Team and endorsed by DoD. This plan created a Public Information Team to act as a liaison between the government agencies and community members. In 1996, AFCEE took the lead on community involvement activities. AFCEE plans 75-100 team and neighborhood meetings every year. The implementation of many cleanup actions would not have been possible without stakeholder involvement and support. A Joint Programs Office (JPO) provides essential services to the base and the community. The JPO coordinates the activities of all the government agencies and acts as a single point of contact for the public. AFCEE is also in the process of forming a Citizens Advisory Team to allow the public to become involved in the decision-making process.

Leonard Pinaud concluded the presentation by presenting an overview of the current remedial activities at the MMR. There are approximately 80 identified source areas at MMR. To date, 50,000 tons of contaminated soil have been thermally treated. The most common treatment techniques employed at the MMR include pump and treat systems, recirculation wells, reactive wells, and monitored natural attenuation. Most plumes have migrated off base.

Perspectives on Impact Area Remediation Activities at MMR

Robert Gill, Air Force Center for Environmental Excellence, Leonard Pinaud, Massachusetts Department of Environmental Protection, and Paul Marchessault, U.S. EPA/Region 1

Since 1911, the training ranges and impact area at MMR have been used for artillery and mortar training as well as munitions R&D testing. There are open burn pits and detonation areas. The site investigation at Camp Edwards resulted in the installation of over 180 monitoring wells. These wells have up to five screened intervals, resulting in roughly 500 ground-water sampling points. To date, over 5,000 soil samples have been collected. Sampling has identified a number of separate areas of concern.

There are several ongoing feasibility studies for ground water and other remediation efforts. The remediation efforts have resulted in the destruction of over 1,700 rounds of munitions in a contained detonation chamber and the recovery of over 2,300 rounds of unexploded ordnance at the J range alone.

RDX and HMX have been detected in both the soils and the ground water. TNT has been detected in the soils, but is generally degraded before reaching the ground water; however, TNT and its degradation products have been detected in the ground water. Perchlorate has also been detected in some monitoring wells. The demolition areas are the most significant source of ground-water contamination, although the artillery detonation area is also a major source of ground-water contamination.

In general, the overall site falls under CERCLA regulation; however, the impact area is being addressed under the Safe Drinking Water Act. As a result, the site is under the dual jurisdiction of the EPA and the Massachusetts Department of Environmental Protection. There are a number of applicable requirements within the Massachusetts National Contingency Plan including the setting of background as the goal of any ground-water remediation effort and a requirement that a study be performed to determine if it is technically feasible to clean up the contaminated ground water to background levels.

Perspectives on the Occurrence of Natural Attenuation in Landfill Plume

Rose Forbes, Air Force Center for Environmental Excellence

The landfill area at MMR consists of five landfill cells and a glacial kettle used for waste disposal. It operated between 1947 and 1989 with final capping completed in 1995. The ground-water plume from the landfill area is approximately 17,300 feet long, 5,500 feet wide, and 35 feet thick—on average—with a maximum thickness of 125 feet. The plume occurs approximately 150-300 feet bgs and ranges from 50-200 feet below the water table along most of its length. The depth below the water table is caused by the large recharge the aquifer receives from annual precipitation, which forces the plume down.

The primary contaminants found in the plume are TCE, PCE, and CCl_4. The remedial design for cleaning up the plume called for treating the water in the northern and southern lobes of the plume and using monitored natural attenuation (MNA) in the central portion. The treatment system for the northern and southern lobes handles approximately 1 million gallons per day.

The suggested MNA scenario for the central portion of the plume is that the leachate from the landfill consists of a solution of dilute (<500 g/L) chlorinated solvents and high total organic carbon (TOC). The high TOC content lead to depletion of oxygen by aerobic degradation. The subsequent anaerobic conditions leads to the degradation of the chlorinated solvents, with vinyl chloride being an endproduct of TCE and PCE degradation. The vinyl chloride is biodegraded as the plume mixes with the aerobic recharge water further downgradient.

The MNA scenario is made possible by the hydrogeology and the existence of an anthropogenic TOC source. Evidence of MNA is seen in the water chemistry of 26 monitoring wells. Wells close to the source show no dissolved oxygen, several types of degradation products (e.g., dichoroethenes, chloroform, vinyl chloride), as well as evidence of anaerobic degradation (e.g., increased dissolved iron, increased methane and carbon dioxide, and decreased sulfate). Wells farther away from the source show decreasing concentrations of degradation products, and there is evidence that the plume is shrinking. Although these conditions have not been observed in the northern lobe of the plume, there is evidence that some degradation is occurring in the southern lobe.

Questions and Answers

Question: Have you detected any ethene, which should be one of the endpoints for vinyl chloride degradation?
Answer: No, but that may be a result of the difficulty in sampling for ethene rather than its absence.

To view Ms. Forbes' presentation materials for more details, click here:

Recirculating Wells at MMR
Spence Smith, Air Force Center for Environmental Excellence

Spence Smith provided an overview of recirculating well technology and its testing at MMR. Also known as ground-water circulation wells or in-well vapor stripping systems, recirculating well systems employ a single well for extraction, treatment, and reinjection (ETR); in-well air sparging or tray-type air stripping; and recirculation of ground water to meet treatment goals. Although recirculating well systems may be considered a form of pump and treat technology, significant differences exist between the two.

At MMR, three types of recirculating well systems were tested between 1996 and 1998 in order to address stakeholder and technology review team recommendations for low-impact, innovative technologies: 1) a vacuum vaporizing well (known as UVB); 2) NoVOCs; and 3) density-driven convection wells. Testing indicated that the performance of recirculation well systems relies on effective recirculation processes that meet the objectives of treatment. The three systems were found to be sensitive to aquifer anisotropy and low hydraulic conductivity layers, but generally effective in source areas where vertical flow is needed to lift different contaminant sources such as DNAPL.

Subsequent cost comparisons (based on a 100-gallon per minute throughput and hypothetical plume) show that recirculation well system costs are greater than ETR systems due to their smaller capture zones and need for multi-pass treatment. ETR unit costs, however, tend to be slightly greater due to the use of a second well, additional piping, and specific backwash requirements.

To view Mr. Smith's presentation materials for more details, click here:

Airborne Magnetometer Surveys at MMR

George D. Gardner, Tetra Tech NUS, Inc.

George Gardner described the airborne magnetometer (AIRMAG) system deployed recently by the National Guard Bureau to detect unexploded ordnance at MMR. The helicopter-mounted AIRMAG system comprises three magnetometer sensors, a laser altimeter/attitude sensor, and a global positioning system. Typically, the system is flown over a site in a series of overlapping paths at a speed of 70 miles per hour and altitude of 3-20 meters. Following aerial activity, computer processing systems are used to remove data "noise" resulting from factors such as varying altitudes and magnetics, and to enhance data for better interpretation.

The system offers significant cost and time savings when compared to traditional ground surveys. Approximately 2,200 acres at MMR were surveyed in five days at a cost of about $1,000 per acre, which is about one-half of the cost estimated for most ground surveys. Detection tests showed that the AIRMAG could detect large (50-100 pound) targets and smaller (155-mm) projectile-like items up to a distance of about 12 meters above ground surface. The system was found to provide general responses at an altitude of 6 meters, but little response at altitudes greater than 15 meters. Anticipated AIRMAG improvements include additional sensor stations on the system platform, vertical gradiometers to help reduce noise from geologic variations, and enhanced data processing software and techniques.

To view Mr. Gardner's presentation materials for more details, click here:

Distribution of Explosives in Soil and Ground Water at MMR

Jay Clausen, Amec Earth and Environmental, Inc.

The ground-water table in the impact area occurs at about 120 feet bgs—primarily within a coarse sand and gravel unit. Over 2,000 soil samples have been collected in and around the impact area, and about half were found to be contaminated. TNT was found in 6.3% of the contaminated soil samples, am-DNT in 32.2%; 2,4-DNT in 1.3%; HMX in 20%; and RDX in 37%. Of the ground-water samples, 65.7% contained RDX in 65.7%, 21.9% contained HMX, and 12.4% contained am-DNT.

There is an approximate 2-mile long plume extending from the impact area. The plume is roughly 3,000 feet wide and contains RDX concentrations ranging from 0.2 to 35 g/L. The plume from "demolition area 1" is about 300-500 feet long and 45 feet wide; since this plume is below a glacial kettle, the depth to ground water is only about 40 feet. The concentrations of RDX in portions of this plume are greater than 100 g/L, and the highest levels of perchlorates have also been found here with concentrations less than 300 g/L. Perchlorate, a solid propellant used in rockets and missiles, presents a particular cleanup challenge because it is soluble, mobile, and persistent.

In conclusion, demolition and disposal activities have had the largest impact on ground water at the MMR impact area. RDX and HMX are present in surface soil adjacent to artillery and mortar targets, and are present in ground water downgradient of the primary target area. TNT, which is a component of the munitions, appears to be degraded before it reaches the ground water. Firing high explosives artillery and mortar rounds appears to have resulted in explosives in ground water at the MMR. Polychlorinated naphthalines (PCNs) may be an issue for soil, and perchlorates are now being detected in the ground water.

Questions and Answers

Question: Is the perchlorate plume the same as the RDX plume?
Answer: Both are recalcitrant compounds and move at approximately the same speed.

Update on Investigations of Contaminated Ground-Water Discharges to Surface Waters at MMR

Denis LeBlanc, U.S. Geological Survey

Denis LeBlanc described several investigations of ground-water discharges to surface water bodies at MMR. The first example was an investigation at the landfill, where a ground-water plume containing 10-15 g/L TCE was believed to discharge into a harbor. The investigators used a boat and a Geoprobe conductance drive system to profile the presence of fresh water in the near-shore sediments. Since retrieving the probe was done by hand, they were limited to how deep they could drive the probe and still pull it up out of the sediments. They found that fresh water was present in a range of about 100 to 500 feet offshore. Following the conductance profiling, they sampled the areas with low conductance using a Geoprobe drive outfitted with a shielded screen. The shield helped prevent sediments from clogging the screen. When the predetermined depth was reached, the shield was withdrawn and a water sample taken. Using this method they were able to delineate the discharge of TCE to the harbor.

The second example was of a ground-water phosphate plume emanating from old sewage treatment beds. The purpose of the investigation was to determine whether the plume discharged to a pond downgradient. From a boat, investigators were able to drive well points several feet into the sediments and take water samples. From the analysis of the water samples, they were able to profile a narrow near-shore discharge area where phosphates ranged from 0.2 to 3.0 mg/L.

The third example involved the use of polyethene diffusion samplers to determine if an ethylene dibromide (EDB) plume was discharging to a stream and a cranberry bog. The polyethylene samplers were filled with ultra-pure water and placed in protective metal cages. The cages were then deployed in the bog ditches and the stream in pairs—one buried in the sediment to measure the discharge of any ground-water contaminants, and one in the surface water itself. Combining the diffusion sampler results with the results from nearby wells, investigators found that while EDB was in the ground water on the upgradient side of the stream, it did not impact sediments and surface water until farther downgradient at the bog. Apparently, the contaminated part of the ground water was sufficiently deep so that the stream and nearest portion of the bog received the overlying clean ground water, while the contaminated water made its way to the surface farther downgradient.

The last example was the investigation of the impact an RDX plume was having on a pond. This investigation was also carried out using diffusion samplers. However, investigators were not sure how well RDX would diffuse across polyethylene, so they used cellulose material that is commonly employed in dialysis. The bags were to be left in place for three weeks. They later discovered that cellulose biodegrades, so they were not able to recover all of the diffusion samplers intact. Also, cellulose has very little structural integrity; so to keep the sampler open, investigators had to place a polyethylene tube with precut holes inside the sampler bag to prevent collapse. A net material was then wrapped around the sampler to protect the cellulose. The analytical results from this investigation have not come back from the laboratory.

To view Mr. LeBlanc's presentation materials for more information, click here:

Perchlorate, Source, and Distribution in Ground Water at MMR

Jay Clausen, AMEC Earth and Environmental, Inc.

Jay Clausen presented background information on issues surrounding the many sites across the country contaminated with perchlorate, and a description of the perchlorate problems currently faced at MMR. Perchlorate contamination presents significant cleanup challenges due to the high solubility, mobility, and persistence of the perchlorate ion (ClO_4^-). Most commonly, perchlorate contamination of ground water results from the use of ammonium perchlorate as a solid propellant for rockets and missiles. Although little information is available on the ecological effects of perchlorate, studies increasingly show that human exposure disrupts normal thyroid functions and iodine uptake.

At MMR, perchlorate concentrations approaching 300 ppb were identified in an area used to demonstrate explosives, while concentrations of up to 10 ppb were found in a nearby offsite well. Extensive studies are underway at MMR to better understand the distribution of perchlorate in ground water and to identify other potential contaminant sources. To date, disposal of rocket motors and propellants has been identified as the primary cause of contamination. Although perchlorate removal efforts have not yet been initiated, it is recognized that ground-water remediation at MMR will require innovative cleanup technologies.

To view Mr. Clausen's presentation materials for more details, including related progress in delineating the distribution of unexploded ordnance in soils at MMR, click here:

THURSDAY TECHNICAL SESSION (ENGINEERING FORUM)

Geosynthetic Clay Liners in Waste Containment
Dave Carson, U.S. EPA/NRMRL–Cincinnati

Dave Carson explained that geosynthetic clay liners (GCLs) are made of a composite material designed for hydraulic containment. They are typically composed of montmorillonite clay (sodium bentonite) sandwiched between two geotextiles or bonded to a geomembrane. Most GCLs are about ¼-inch think and come in panels that are less than 20-feet wide. GCLs can be used in waste containment cover systems, as part of composite waste containment bottom liner systems, when suitable borrow soils are not available or economical, or in temporary or permanent secondary containment of tanks. GCLs exhibit a number of characteristics that make them suitable for use in containment, including:

- Consistent hydraulic properties
- Consistent engineering properties
- Relatively high manufacturer quality control
- Thinness (maximizes landfill volume)
- Variety of material choices to satisfy site-specific requirements
- Availability at every project
- Simplified installation and construction quality control
- Some self-healing capabilities
- Simplified repair
- Simplified installation of penetrations in covers
- Cost competitive with compacted clay liners (CCLs) and geomembrane systems

There are concerns that CCLs will not retain hydraulic properties over time due partly to desiccation from above and below. CCLs are also subject to cracking during differential settling and freezing. Finally, CCLs are difficult to place and compact, especially on slopes. GCLs are often offered as replacement or partial substitutions for CCLs. GCLs, like any other engineering materials, have unique properties that allow them to perform similarly to, or outperform, CCLs.

When selecting a GCL, a site manager should perform conformance testing and watch to be sure that the material tested is the same material that is delivered to the site. GCLs often have differing materials on either side with widely varying friction properties. Placing a GCL upside down can cause slope failure.

GCL placement is a delicate process; GCL rolls are heavy, easily ripped, and should be handled with appropriate equipment. RPMs should always follow the designer's instructions on installation. GCLs must be anchored in place, often with a liner anchor trench. As manufactured, GCLs appear to resist damage done by freeze and thaw cycles in laboratory tests. GCLs should not be used in areas with high concentrations of leachable calcium, magnesium, or polyvalent cations.

Dave presented a few case studies involving GCLs. EPA has been doing limited research on GCLs. Some of the ongoing research areas include:

- field performance of liner systems
- long-term assessment of GCL slope stability
- root penetration of unprotected GCLs
- permeation behavior under municipal solid waste leachate of varying age

Forum members can refer to the following EPA publications for more information:

- *Assessment and Recommendations for Optimal Performance of Waste Containment Systems* (to be finalized soon)
- *Geosynthetic Clay Liners Used in Municipal Waste Landfills*, EPA 530/F-97/002
- *Report of 1995 Workshop on Geosynthetic Clay Liners*, EPA 600/R-96/149
- *Report of Workshop on Geosynthetic Clay Liners*, EPA 600/R-93/171
- *Compilation of Information on Alternative Barriers for Liner and Cover Systems*, EPA 600/2-91/002

Key GCL References

Designing with Geosynthetics, Koerner, 1998
Final Covers for Solid Waste Landfills and Abandoned Dumps, Koerner and Daniel, 1997
Geosynthetic Clay Liners, Koerner, Gartung, and Zanzinger, 1995
Geotechnical Practice for Waste Disposal, edited by Daniel, 1993

GCL Websites

The Geosynthetic Institute: www.geosynthetic-institute.org
CETCO (Bentomat, Bentofix): www.cetco.com
Naue Fasertechnik: www.naue.com
www.bentofix.com
www.serrot.com
GSE (GundSeal): www.gseworld.com
Huesker (NaBento): www.huesker.com

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